INFORMATION SCIENCE TEAM

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INFORMATION EXTRACTION AND DATA HANDLING

OBJECTIVES

- Help identify bounds of practical missions
- Identify data handling and analysis scenarios
- Identify and supply the required enabling technology
- Identify and supply the design data base for parameter selection
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data handling aspects of system design

• enabling technology for data handling

• enabling technology for analysis
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INFORMATION EXTRACTION MILIEU - POTENTIAL MODES

- Support to individual P.I. research
- Organized support to research tasks
- Design of systematic research program data system
- Support to research data system operation
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Common Themes - Analysis

- Analysis of atmosphere problems needs solution
- Effects of better resolution (spatial, spectral) promising but unproven
- Registration problems will be worse with smaller pixels
- Off-nadir viewing promising, but will add new problems
- Geographic information system development needed to allow analysis tasks to concentrate on analysis
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Common Themes - Data Handling

- Parameter selection for research system needs data base
- Research scenarios will be different than operational scenarios
- Research program will collect large amounts of data - data handling must be efficient
- VLSI and other new technologies must be adapted to remote sensing research needs
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SYSTEM DESIGN

STATUS
- Present system (Landsat) is survey-mode with centralized processing and archive
- Data delivery is manual (tape), slow
- Minimal special processing available
- Little data other than from MSS available

CONTRIBUTING FACTORS
- System is experimental but operational use is attempted
- Open skies implies more data processing than otherwise needed
- Data analysis has concentrated on Landsat data
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SYSTEM DESIGN

CRITICAL ISSUES
- Increasing data rates will make future system design more critical
- Production efficiencies must be evaluated even in an experimental system
- No design data base for future mission design
- Data form causes user problems, particularly in registration

Recommendations For Investigation
- Alternate system architectures need study
- Provide data base for design of future missions
- Include user information extraction models in system design
- Provide data in optimum form
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Data Handling Technology

Status

- Decreasing memory costs allow more computer memory and the related increased processing capability
- Microprocessor capabilities increasing rapidly
- New storage medium (digital video disks) imminent
- Very large scale integrated circuit (VLSI) technology improving, but no developments particularly for remote sensing

Contributing Factors

- Sales volume for remote sensing not sufficient to drive the technology
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Data Handling Technology

Critical Issues

- Increasing data rates will overload present-technology systems
- Present system design, based on mag tape, hinders random access
- Systems for handling geographic data in infancy

Recommendations For Investigation

- New technologies allow new system configurations - Design studies needed:
  - Centralized vs. distributed processing
  - On-board vs. ground processing
  - Data compression
  - Video disk technology
  - VLSI
- Sponsor the development of comprehensive geographic information systems
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Rectification and Registration

Status
- Rectification is required on every image
- Registration accuracy generally 0.5 to 1.5 pixels
- Paucity of worldwide maps prohibits geodetic image location
- Interpolation effects still not generally understood/accepted
- Large area mosaicking is tedious

Contributing Factors
- Ephemeris and attitude knowledge is insufficient for geodetic location without ground control
- Ground control often not available, even with maps
- Intrimage distortions (e.g., Landsat-D) particularly troublesome
- Interpolation variably affects analysis
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Rectification and Registration

Critical Issues

- Intrimage distortions in sensor must be avoided
- Ephemeris and attitude knowledge need improving
- Control point correlation needs further study
- Registration of off-nadir images will be difficult
- For the related aircraft data, attitude knowledge and registration are severe problems

Recommendations for Investigation

- Determine how best to use control points
- Determine how to verify geometric performance
- Determine effects of (various) data compression techniques on registration
- Further study the effects of interpolation
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INFORMATION EXTRACTION ANALYSIS

Status

- Low-dimensionality analysis maturing (spectral and spatial)
- High-dimensionality analysis primitive (spectral and spatial)
- Temporal analysis is ad hoc; agriculture phenologic stage analysis is maturing

Contributing Factors

- Registration and data handling problems have hindered analysis efforts, particularly with multiresolution data
- Sensor and data characterizations have been incomplete
- Generalized modeling techniques are inadequate
- Equipment diversity hinders interchanges
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INFORMATION EXTRACTION - ANALYSIS

CRITICAL ISSUES

- Utility of absolute radiometrically calibrated data is unknown
- Utility of greater radiometric resolution is unknown
- Utility of higher spatial resolution exciting but unproven
- Utility of more spectral bands exciting but unproven
- High-dimensionality analysis promising but difficult

RECOMMENDATIONS FOR INVESTIGATION

- Conduct experiments with parameters exceeding expected mission parameters to determine utility thresholds
- Provide methods for cross-discipline fertilization
- Determine better ways of converting analysis concepts to software
- Investigate and characterize total system including atmosphere
- Investigate the use of higher-dimension analysis such as Texturf
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INFORMATION EXTRACTION - ENABLING TECHNOLOGY

Status

- Geometric operations and multispectral classification (especially) require excessive amounts of computer time
- Large system operation is expensive; small systems are limited
- Several moderate size systems are available, based on general purpose computers
- Geographic information systems are used but are specialized, inflexible, and diverse

Contributing Factors

- Remote sensing requirements not extensive enough to cause specialized technology developments
- Software development has not been sponsored to the point which would coalesce the various Ad Hoc systems
- Lack of data commonality standards hinders the use of geographic data
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INFORMATION EXTRACTION - ENABLING TECHNOLOGY

CRITICAL ISSUES

- Geographical processing algorithms and the ever-increasing data set size are outstripping general purpose computer capabilities
- Lack of software and data interchange standards hinder cross-fertilization

RECOMMENDATIONS FOR INVESTIGATION

- Investigate the possible analysis software modifications to allow the use of VLSI
- Investigate potential new computer architectures suitable for geographic (spatial) problems
- Promote the development of modular hardware and software to allow wider technology interchange
- Investigate/develop networking systems to allow non-local processing
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. POTENTIAL SUPPORT MODE - SUPPORT TO INDIVIDUAL P.I.

- Encourage PI data commonality
- Assist PI data interchange
- Sponsor cross-discipline research

E.g., Atmosphere studies
Object size distributions
Interpolation
Registration
Off-nadir viewing
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POTENTIAL SUPPORT MODE - ORGANIZED SUPPORT TO RESEARCH TASKS

- PROVIDE CROSS DISCIPLINE DATA SOURCES (E.G., AIRCRAFT, SHUTTLE, ... INSTRUMENTS AND FLIGHT SUPPORT)

- PROVIDE COORDINATED DATA SETS VIA GEOGRAPHIC INFORMATION SYSTEMS

- FACILITATE CROSS DISCIPLINE DATA DISTRIBUTION

- DEVELOP VLSI FOR EFFICIENT DATA HANDLING

- SPONSOR CROSS DISCIPLINE RESEARCH (AS ABOVE)
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Potential Support Mode - Systematic Data System Design

- Gather the decision data base to enable parameter tradeoffs
- Perform tradeoff studies such as:
  - On board vs. ground processing
  - Data compression techniques
  - Optimum bit allocation (spatial vs. spectral vs. quantization)
  - System mode
- Sponsor cross-discipline research
- Develop archival/retrieval techniques
- Develop GIS, formatting and labeling techniques
- Develop VLSI and new system architecture as required
- Develop other system-enabling technologies such as video disks
- Develop techniques for providing multitype data sets
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POTENTIAL SUPPORT MODE - SUPPORT TO SYSTEM OPERATION

• Provide (an) efficient archival/catalog/retrieval system(s)
• Provide efficient GIS, labeling and formatting guidelines
• Implement new system designs, with VLSI as applicable
• Provide system characterization